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(54) Attacking ground targets

(57) When attacking ground targets from an airborne weapons carrier (1) with a projectile 3 launchable rearwardly at angle α from a firing device 2, the horizontal component $-V_h$ of the projectile ejection speed V_a and the forward velocity V_h of the carrier are made equal in magnitude. A substantially vertical descent path is obtained, which counteracts errors in determining altitude H. A computer 5 may determine firing time t_z in accordance with a residual difference between V_h and a pre-selected value of $-V_h$, and may control an autopilot 14 which maintains V_h and H constant. Target distance E_z may also be fed to the computer 5, so that a pre-selected distance the flight velocity controls of the autopilot are actuated.

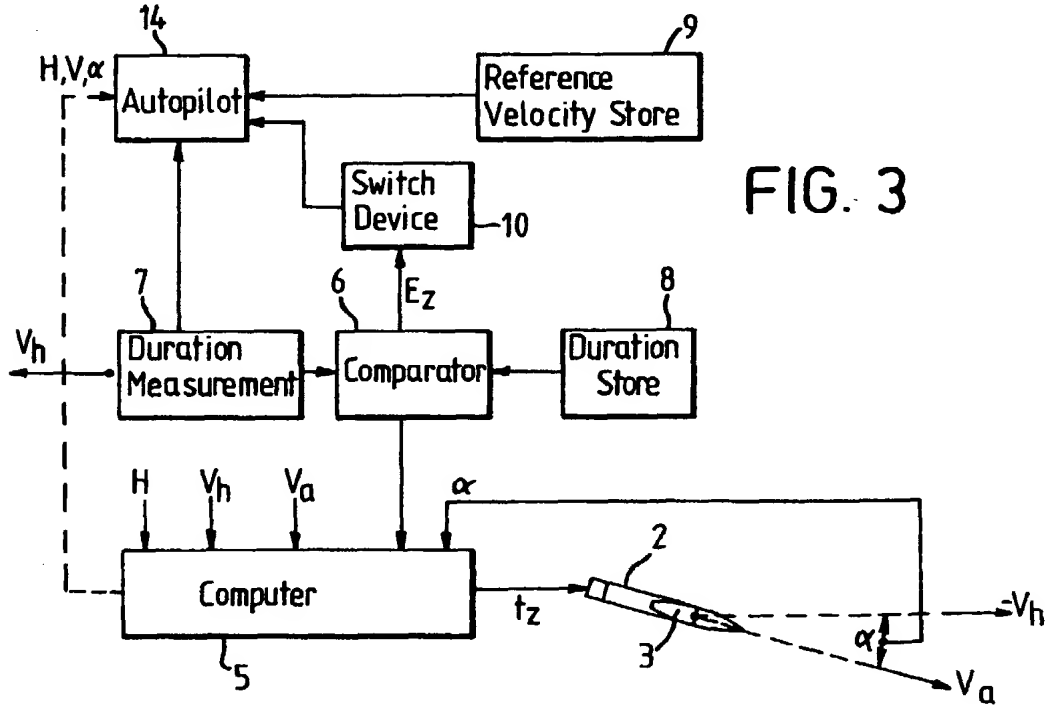

FIG. 3

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FIG. 1

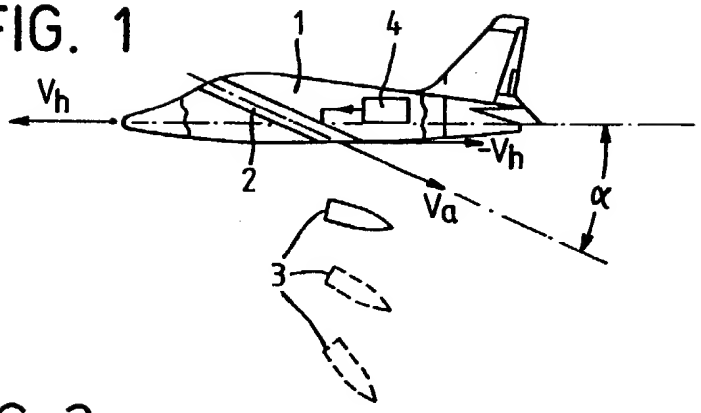
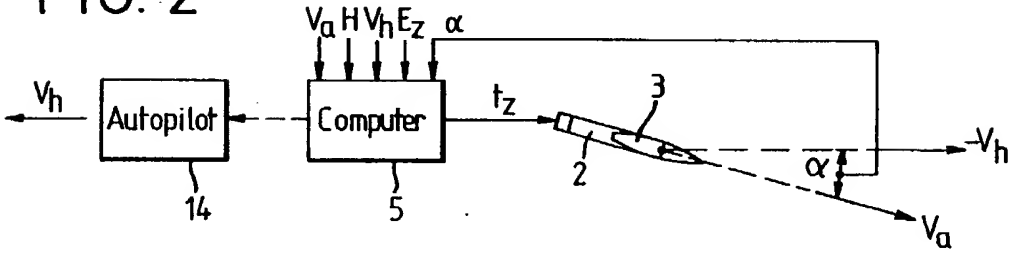


FIG. 2



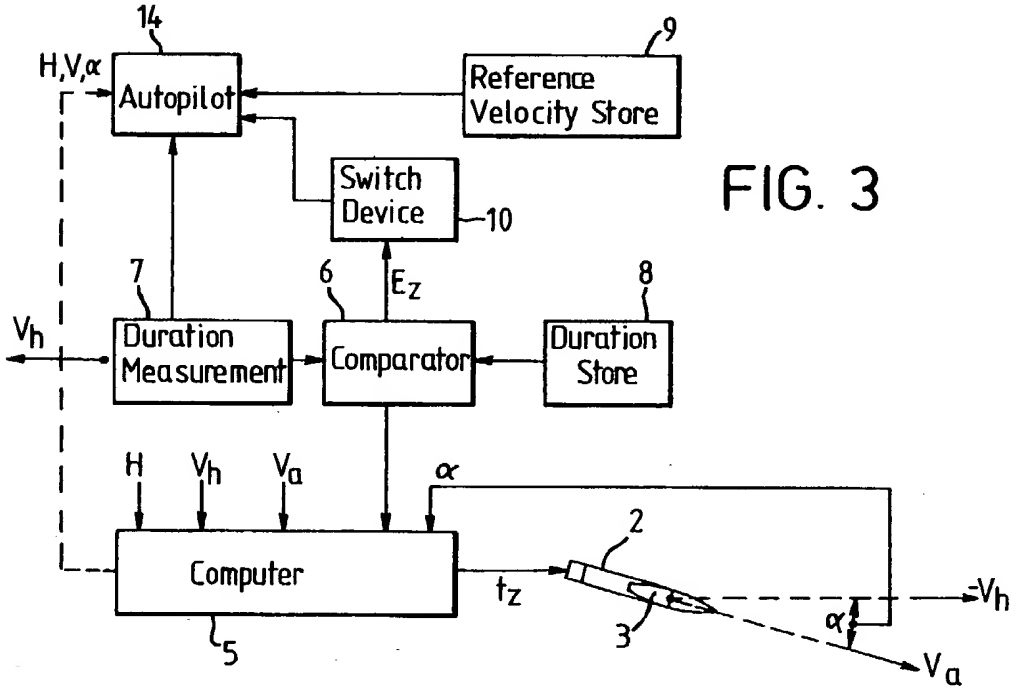


FIG. 3

SPECIFICATION

Apparatus for combating ground targets and mounted on a low-flying weapon carrier

The invention relates to an apparatus for combating ground targets by the aid of a projectile ejectable from a flying weapon-carrier.

Remote-controlled or automatically controlled flying weapon-carriers, such as aircraft or rockets, equipped with ammunition which can be dropped or fired, in order to combat ground targets, necessitate complicated actuating devices in order to ensure as accurate a hit as possible.

A number of values have to be accurately measured for the purpose and a number of conditions very accurately fulfilled. It is not possible, with known apparatus on weapon-carriers approaching the target at a high velocity and at a low altitude, for all these demands to be accurately met. In particular, even minor errors in determining the flight altitude the bomb to be dropped a good distance from the target in high-speed low-flying, owing to a considerable speed component of the bomb in the direction of flight, so that great quantities of ammunition, with comparatively heavy and expensive aircraft, have to be used if the targets are to be successfully attacked.

For an apparatus of the kind mentioned at the beginning the purpose of the invention is to enable it to be so constructed that with relatively moderate over-all expenditure on technical equipment a high degree of accuracy in rapid low flight is obtained for an ejectable projectile.

The invention enables this obect to be achieved as a result of the fact that the flying weapon-carrier is fitted with an aiming device to which are connected regulating devices which with the horizontal velocity V_h of the weapon-carrier can be set so as to be equal in magnitude to the expulsion speed $-V_h$ of a projectile, taking the opposite direction, and with which the projectile, ejectable at a descending angle from a firing device, can be released in the nadir above the target. The resulting ballistics, from steep to vertically downwards, ensure that if determined incorrectly the flight altitude will only deviate very slightly, if at all, from that required for a hit.

On the other hand, with sufficiently controllable means, the released moment can be determined with a high degree of accuracy, and a preselected ejection speed for the projectile can likewise be very accurately maintained, at only moderate cost, so that the apparatus described generally enables the deviations from the correct position for a hit to be greatly reduced by comparison with conventional apparatus, particularly at low flight altitudes and under unfavourable weather conditions.

Both for the aiming device and for the operation of guilding the projectile, use can be made of relatively simple and merely approximate altimeters.

In a further version of the invention the firing devise* is provided with a computer by which the moment at which the firing device is to be actuated is determined in accordance with a residual difference between the horizontal velocity V_h of the weapon-carrier and a preselected horizontal ejection speed $-V_h$ of the projectile, taking the opposite direction.

In an advantageous further embodiment of the invention the weapon-carrier is equipped with an autopilot which is controlled by the computer and which has devices serving to maintain a preselected flying altitude and horizontal velocity. These last two conditions can be fulfilled with relatively simple known means.

A special further version of the invention makes an additional contribution to the increase in the accuracy in that the weapon-carrier has a device for continuously determining the duration of electromagnetic waves emitted from at least two control points, as well as a device which compares these measured periods with further equivalent target coordinates fed into a store of the weapon-carrier and which is associated with the computer, which determines therefrom the actual positional values of the weapon-carrier and the horizontal distance and also direction to the target.

*To read: "aiming device"? (See Claim 2). Translator.

It has been found that target coordinates which in accordance with a further development of the invention have been obtained in an analogous manner by the aid of a reconnaissance projectile and fed into the store of the weapon-carrier provide greater accuracy than comparative data obtained from maps of the terrain.

In a further developement of the invention the apparatus is so designed that an invariable ejection speed for the ammunition is ensured by the adoption of a suitable construction for the propulsive charges and by adapting to the said speed the flight velocity of the weapon-carrier, controlled by the computer. In this system it is sufficient if by the aid of a control device associated with the comparator device and the autopilot the exact flight velocity is only regulated by means of the aforementioned devices in the vincinity of the target, while on the launching and approach sections of the traject only simple flight regulators are in operation. This measure enables use to be made of relatively simple measuring and regulating means known *per se*. In the construction of the propulsive charges for the ejectable projectile it is desirable to employ techniques that have proved their value and ensure freedom from recoil.

For error correction purposes a further version of the invention may be adopted in which, at all events in the vicinity of the target, the angle of inclination of the firing device and/or the flight traject of the weapon-carrier, as well as the angle of thrust of this latter, are controlled by the computer.

Further details of the invention are described below by reference to the example illustrated in the drawing. The diagrams are as follows:

Figure 1 a schematically simplified flying weapon-carrier shown in longitudinal section and having a built-in apparatus for combating ground targets.

Figure 2 a block diagram of the apparatus shown in Fig. 1.

Figure 3 an extended block diagram of the apparatus shown in Fig. 2.

The flying weapon-carrier as shown in Fig. 1 is equipped with a propulsion unit of the known kind and not shown in the drawing, e.g. with a relatively simple air-breathing propulsion unit of adjustable thrust, and with devices, likewise of a known kind, for remote control. For the purpose of combating ground targets it is provided with a firing device 2 inclined downwards, in the opposite direction to its flight, by an angle α. From this firing device a projectile 3 can be ejected with a horizontal velocity component $-Vh$, which is equal in magnitude but opposite in direction to the horizontal velocity component V_h of the weapon-carrier 1. For the traject of the projectile 3 this results in ballistics ranging from very steep to vertically downwards, and simple consideration of the matter will show that in this system, unlike conventional firing devices, which eject the projectile in the direction of flight or downwards, the flight altitude above the target is only of secondary importance for an accurate hit. On the other hand, however, the speed of the weapon-carrier itself can be accurately adjusted by conventional and relatively simple means in such a way that it corresponds to an ejection speed V_a of the projectile 3 which can likewise be kept constant at relatively low cost. By comparison with known apparatus for combating ground targets it follows from the foregoing that the system provides considerably improved accuracy, particularly when the weapon-carrier is flying at a high speed and at a relatively low altitude.

It is of advantage for the proj ctile 3 to be fired by the aid of a further version of the device 2, shown in Fig. 2, and the aiming device 4, by which the moment of ignition t_z is determined by means of a computer 5, into which, by known electronic means, the data regarding the horizontal velocity V_h, the distance E_z of the weapon-carrier 1 from the target, the ejection velocity V_a and the angle of inclination α of the firing device 2 have been fed, the latter being possibly variabl by means of control devices of a known type. To the computer 5 is also connected an autopilot 6 known *per se*, which serves to guide the weapon-carrier and which is additionally controlled in accordance with data which are present in the computer and which have been fed into it by suitable known means. In this system the flight altitude can be fed in with comparatively inaccurate measuring devices, e.g. a barometric altimeter.

To improve the accuracy still further the computer 5 is provided with special locating devices which are shown in Fig. 3 and which are described in detail in the old German patent application P 25 32 479.2.

In this system the computer 5 is fed with information on the target distance E_z by means of a comparator device 6, to which are connected a device 7 for measuring the duration of electromagnetic waves and a store 8 for duration coordinates of the target. The device 7 for measuring the duration mainly consists of a receiver which simultaneously or in alternation receives signals emitted by two aerials, whicle analogous target coordinates, obtained by the aid of a reconnaissance projectile, are present in the duration store 8. The signals obtained from the two devices 7 and 8 are converted, in the comparator device 6, into target distance signals E_z and conveyed to the computer 5. This provides, for the weapon-carrier 1, a highly accurate continuous location system which at relatively low cost surpasses the accuracy of maps.

The device 7 for measuring the duration also contains signals which are conveyed to the autopilot 4 via the computer 5 and which are thus utilized for the purpose of automatically guiding the weapon-carrier 1 to the target.

From the altimeter the autopilot receives signals for regulating the flight altitute H, while from the computer the signals are received for regulating this velocity V of the weapon-carrier and for maintianing the angle of inclination α at the ignition moment t_z for the firing device 2, a store 9 for the reference velocity being associated with it.

In the manner indicated the horizontal velocity V_h of the weapon-carrier 1 is coordinated, by the aid of a propulsion unit regulator of a known kind, not shown in the drawing, or by means of braking devices (spoilers), likewise already known, with the preselected ejection speed V_a of the projectile 3. For this purpose a switching device 10 is provided by means of which, when a certain preselected distance from the target is reached, and by the aid of a signal supplied from the comparator d vice 6, the velocity regulation devic s associated with the autopilot 4 can be switched on.

The influence of head wind and tail wind, owing, to the very short time which the projectile takes to fall, has practically no effect on the accuracy with which the target is hit. In the case of side winds, however, positional

deviation may be caused, for example, by thrust of the weapon-carrier, and is remedied by the fact that the aiming device 4 is provided with means known *per se* and serving to take into account the influence of the side wind, once again fulfilling the condition that the horizontal velocity of the weapon-carrier should be equal to the horizontal velocity, taking the opposite direction, of the projectile.

The entire apparatus for combating ground targets and also the guilding device for the weapon carrier involve relatively moderate over-all expenditure, mainly thanks to the use of an aiming device with vertical weapon ballistics in conjunction with a device for measuring the duration. Hitherto, even with considerably greater expenditure, no comparable accuracy has been obtainable with the use of large or manned aircraft flying at high velocity and low altitude. A further special advantage of this apparatus resides in the fact that altimeters of relatively low accuracy, e.g. of the barometric type, are sufficient. A further advantage offered by the apparatus, by comparison with disposable projectiles, resides in the fact that a flying weapon-carrier can direct projectiles in succession to targets situated at a distance apart. For this purpose, for instance, a reloading firing device 2 or a multiple arrangement of firing devices may be provided.

CLAIMS

1. Apparatus for combating ground targets by the aid of a projectile ejectable from a flying weapon-carrier, characterized by the fact that the flying weapon-carrier 1 is fitted with an aiming device 4 to which are connected regulating devices which with the horizontal velocity V_h of the weapon-carrier can be set so as to be equal in magnitude to the expulsion speed $-V_h$ of a projectile 2, taking the opposire direction, and with which the projectile 3, ejectable at a descending angle α from a firing device 2, can be released in the nadir above the target.

2. Apparatus in accordance with Claim 1, characterized by the fact that the aiming device 4 is provided with a computer 5 by which the moment t_z at which the firing device is to be actuated is determined in accordance with a residual difference between the horizontal velocity V_h of the weapon-carrier and a preselected horizontal ejection speed $-V_h$ of the projectile, taking the opposite direction.

3. Apparatus in accordance with Claim 2, characterized by the fact that the weapon-carrier 1 is equipped with an autopilot 4 which is controlled by the computer 5 and which has devices serving to maintain a preselected flying altitude H and horizontal velocity V_h.

4. Apparatus in accordance with one of the foregoing Claims, characterized by the fact that the weapon-carrier 1 has a device 7 for continuously determining the duration of electromagnetic waves emitted from at least two control points, as well as a device 6 which compares these measured periods with further equivalent target coordinates fed into a store 8 of the weapon-carrier 1 and which is associated with the computer 5, which determines therefrom the actual positional values of the weapon-carrier 1 and the horizontal distance E_z and also direction to the target.

5. Apparatus in accordance with Claim 4, characterized by the fact that the target coordinates are determined in the store 8 by the storage of duration measurements which have been obtained by means of a reconnaissance aircraft.

6. Apparatus in accordance with one of the foregoing Claims, characterized by the fact that the comparator device 6 is provided with a switching device 10 by which the flight velocity regulating devices of the autopilot 14 are switched on when a certain preselected distance E_z from the target has been reached.

7. Apparatus in accordance with one of the foregoing Claims, characterized by the fact that in the vicinity of the target the computer 5 additionally controls the angle of inclination α of the firing device 2 and/or the flight traject of the weapon carrier 1.

8. Apparatus in accordance with one of the foregoing Claims, characterized by the fact that the aiming device 4 is provided with correcting devices for the influences of the side wind.

CLAIMS

Amendments to the claims have been filed, and have the following effect:–

(a) Claims 1–8 above have been deleted or texually amended.

(b) New or textually amended claims have been filed as follows:–

1. Apparatus for attacking ground targets using a projectile ejectable from an airborne weapon carrier, wherein the weapons carrier includes an aiming device coupled with control means through which the horizontal velocity of the weapons carrier can be set so as to be comparable in value but opposite in direction to the horizontal component of the expulsion speed of a projectile, the projectile being ejected at a descending angle from a launching device and released when above the target.

2. Apparatus in accordance with Claim 1, wherein the aiming device is operatively coupled with a computer which defines the instant at which a firing device initiating expulsion of the projectile is actuated and determined in accordance with the difference between the horizontal velocity of the weapons carrier and a preselected horizontal ejection speed for the projectile in the opposite direction.

3. Apparatus in accordance with Claim 2, wherein the weapons carrier has an autopilot

controlled by the computer and with means to maintain a preselected altitude and horizontal velocity.

4. Apparartus in accordance with Claim 2 or 3, wherein the weapons carrier has a means for continuously determining the time difference between electromagnetic waves emitted from at least two control points and means to compare the measured periods with coordinates of a target fed to a store in the weapons carrier which is associated with the computer, the computer determining the actual position coordinates of the weapons carrier and thus the horizontal distance and direction to the target therefrom.

5. Apparatus in accordance with Claim 4, wherein the target coordinates are determined in a store by storage of duration measurements which have been obtained from a reconnaissance aircraft.

6. Apparatus in accordance with Claim 4 or 5, wherein a comparator device has a switching means through which a flight velocity control means of an autopilot are switched on when a certain preselected distance from target is reached.

7. Apparatus in accordance with any one of the preceding Claims 2 to 6, wherein the computer controls either the angle of inclination of the aiming device when in the vicinity of the target or the flight path of the weapons carrier or both.

8. Apparatus in accordance with any one of the preceding Claims, wherein the aiming device includes means for correcting the flight path for cross-wind components.

9. Apparatus for attacking ground targets from an airborne weapons carrier substantially as herein described with reference to the accompanying drawings.

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